

NIST’s Contribution in Response to M1/06-0949 Call for Contributions, Biometric Sample Quality Draft M1/06-0948

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- Topics: 1. Quality Score Percentile Rank (QSPR)
2. Achieving Interoperability through Quality Score Normalization Dataset (QSND)

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1. Quality Score Percentile Rank (QSPR)

Table below compares QSND and QSPR as proposed by Aware Inc. in document M1/06-0979.

QSPR	QSND
GOAL: To establish a normalization of vendor scores to a common range of [0,100]	GOAL: To establish a normalization of vendor scores to a common range of either [0,100] or [0,4] as specified by BioAPI
DATA: Needs a big, wide ranging, balanced, standard data set, which currently does not exist	DATA: Needs a big, wide ranging, balanced, standard data set, which currently does not exist
OVERHEAD: A mapping and/or calibration, which is done once before implementation is shipped	OVERHEAD: A mapping and/or calibration, which is done once before implementation is shipped
STORAGE:	STORAGE: It has been proposed to reserve a bit in the view header to indicate if the scores of the quality algorithm vendor on QSND has been reported.
FATAL if reference database is not diverse in quality. Because if the reference set is not diverse, i.e. variation in quality is small or negligible, the cumulative distribution function will be a steep “S”-shaped function. That makes most samples to have same percentile rank (0 or 100) without any distinction.	Not FATAL if the reference database is not diverse in quality.
Not an indicator of performance Knowing that percentile rank of raw score of 43 only means that 4% of the dataset are below quality 43. It does not provide any information on what the expected performance of samples with raw score of 43 would be.	Indicator of performance The reference dataset is quality annotated where quality scores are, by design, indicator of performance.

2. Achieving Interoperability through Quality Score Normalization Dataset (QSND)

Quality Algorithm ID (QAID) allows distinguishing among different quality scores generated by different algorithms, but it does not provide sufficient information for open interchange of quality scores. That means it does not ensure interoperability, which is one of the goals of any standardization process. The burden of interpretation of quality score is the responsibility of the recipient of the score, who needs external knowledge to make use of the quality scores. That often requires the recipient of the quality scores to either rely on extrinsic data provided by the quality algorithm vendor (which may not exist) or perform some tests on its own to interpret quality scores (e.g. to find out what score of 54 means, should attempt recapture or not.).

The issue of lack of interoperability of quality scores is even more burdensome when the quality algorithm used at the time of enrollment is different than the one used for authentication. Both Germany (ISO/IEC JTC 1/SC37 N982) and Singapore (ISO/IEC JTC 1/SC37 N1354) have addressed the issue of lack of interoperability with QAID and both have suggested some means of calibration of quality scores through QSND.

To facilitate use of quality scores and to improve interoperability of exchanging quality scores of biometric data, vendors are encouraged to provide quality scores as computed by their quality algorithm specified by Quality Algorithm Vendor ID on some standardized reference data or Quality Score Normalization Data Set (QSND). The Quality Score Normalization Dataset (QSND) is a standardized quality-annotated set of images. For each modality, several sample data that falls into each four classes of quality specified by BioAPI will be collected and made available in the standards for the users and

developers of quality algorithms. Example below shows the simplest way of how QSND can be used to interpret raw quality scores of different vendors and facilitate interoperability of those scores. Let's assume Table 1 shows Vendors X and Y quality scores on a published QSND. A mapping from vendor X and Y's quality score to BioAPI's quality class can be performed by, for example, computing range of vendors' X and Y quality scores for each BioAPI class of quality. Such a mapping is shown in Table 2. This mapping gives context to the raw quality scores of vendors X and Y (e.g. samples with quality 5 as computed by vendor Y are of poor quality and recapture is advised) and provides interoperability between vendor X and vendor Y quality scores (e.g. same performance is expected for samples of quality 5 computed by vendor Y and samples of quality smaller than 43 computed by vendor X). Obviously more sophisticated methods than simply computing the range as suggested above could be used to perform the mapping from raw quality scores to BioAPI classes of quality.

Table 1. Quality scores of multiple vendors computed over QSND

Image-id	Ground Truth	Vendor X	Vendor Y
100_03_02	excellent	89	1
100_12_01	excellent	68	2
100_12_02	excellent	74	2
100_15_02	excellent	92	2
100_16_01	excellent	90	1
100_16_02	excellent	83	1
100_20_01	excellent	77	2
100_20_02	excellent	69	1
101_08_02	excellent	72	2
101_12_01	excellent	85	1
001_08_02	adequate	59	3
001_12_01	adequate	57	3
001_20_01	adequate	64	3
004_01_02	adequate	62	3
004_07_01	adequate	58	3
004_11_01	adequate	67	2
004_16_01	adequate	55	3
004_20_01	adequate	72	3
006_12_01	adequate	60	3
006_12_02	adequate	62	4
001_01_02	marginal	46	4
006_03_01	marginal	45	4
006_07_01	marginal	45	4
007_01_01	marginal	47	4
010_07_02	marginal	50	4
018_11_01	marginal	45	4
019_16_01	marginal	44	5
021_07_02	marginal	48	4
021_12_01	marginal	51	4
021_12_02	marginal	48	3
016_07_01	unacceptable	36	5
021_16_01	unacceptable	33	5
022_02_01	unacceptable	39	5
050_12_01	unacceptable	42	4
051_07_02	unacceptable	44	5
058_15_02	unacceptable	40	5
066_15_01	unacceptable	40	5
067_19_02	unacceptable	32	5
075_06_02	unacceptable	39	5
078_07_02	unacceptable	42	5

Table 2. An example of mapping vendors X and Y quality scores to BioAPI classes of quality based on Table 1.

BioAPI quality category	Quality scores of Vendor X mapped to BioAPI quality categories	Quality scores of Vendor Y mapped to BioAPI quality categories
excellent	68 – 89	1,2
adequate	55 – 67	3
marginal	44 – 54	4
unacceptable	30 – 43	5